Bionomy of Mosquitoes (Diptera, Culicidae) in the Inundated Region of Southern Moravia

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Abstract. The paper contains results of the long-term studies on the phenology of mosquitoes in southern Moravia carried out within the framework of the research of the natural focus of the Tahyňa virus in this area. Observations were made on the influence of hydrologic conditions in the inundated area of the river Dyje during 1962—1966 and on the influence of some additional ecological factors upon the species composition and numbers of mosquito population. Southern Moravia is one of the most important regions of calamitous occurrence of mosquitoes in Czechoslovakia. In the inundated area of the rivers Dyje and Morava a mass hatching of mosquitoes, particularly of the genus Aedes occurs following regular annual floods (KRAMÁŘ, WEISER 1951, ROSICKÝ, WEISER 1952, NOVÁK 1962 etc.). Apart from pestered people and animals, particularly during their work in the forest, the mosquitoes in this area may also transmit causative agents of some diseases. The virus Tahyňa (KOLMAN et al. 1964) and Čalovo (SMETANA et al. 1967) were repeatedly isolated here. The bionomy of mosquitoes in southern Moravia was studied in connection with the research of the natural focus of the Tahyňa virus in the Drnholec locality (MÁLINKOVÁ et al. 1965).

MATERIAL AND METHODS

During 1962—1965 studies were conducted in southern Moravia in the basin of the river Dyje in the area of Drnholec as far as the confluence of the Dyje with the Morava river. Regular observations were made at 10—14 day intervals throughout the vegetative season of mainly two localities; an isolated inundated forest between Drnholec—Novosedly—Jevišovka on the left bank of the Dyje and an inundated forest with adjoining meadows between the arms of the Dyje near Nejdek and Lednice. In 1966 regular observations were made particularly of the locality Drnholec.

The numbers of larvae were ascertained by means of quantitative collection according to method of MINÁŘ (1962). To obtain samples from shallow water and in localities where this method could not be employed, we used dipper techniques by strainers 15 cm in diameter and 50 cm long (MONCHADSKY 1952). The adults were captured in entomological nets without selection at the time of maximal activity of mosquitoes (MINÁŘ 1959, TRPIŠ 1962) i.e. when they were alighting at the collector and when they were chased away from their shelters in vegetation. All collections were converted to half-hour catches per one person.

The water temperature in hatching sites at the depth of 10 cm was continuously measured by adapted thermohygrographs Metra 851, floating on polystyrene floats (HÁJKOVÁ 1966a). The data
on the frequency of precipitation, air temperature and extent of floods were obtained from the Hydro-
meteorologic Institute in Prague and from the south-Moravian observation stations. The water leve-
\[\text{in the Dyje is given according to the records on the stream gauge profile at Dolní Věstonice.}\]

A total of 14,548 larvae and 161,270 adults were dealt with.

RESULTS

SPECIES COMPOSITION OF THE MOSQUITO FAUNA IN SOUTHERN
MORAVIA

During our studies 5 genera and 24 species of mosquitoes were ascertained in the
area studied: \textit{Aëdes vexans} Meigen, 1830, \textit{Aë. cinereus} Meigen, 1818, \textit{Aë. cantans}
(Meigen) 1818, \textit{Aë. excrucians} (Walker) 1856, \textit{Aë. flavescens} (Müller) 1764, \textit{Aë.
annulipes} (Meigen) 1830, \textit{Aë. caspius} (Pallas) 1771, \textit{Aë. dorsalis} (Meigen) 1830, \textit{Aë.
communis} (De Geer) 1776, \textit{Aë. sticticus} (Meigen) 1838, \textit{Aë. leucemelas} (Meigen)
1804, \textit{Aë. cataphylla} Dyar, 1916, \textit{Aë. intrudens} Dyar 1919, \textit{Aë. geniculatus} (Olivier)
1791, \textit{Culex pipiens} Linné, 1758, \textit{C. modestus} (Ficalbi) 1890, \textit{Anopheles claviger}
Meigen, 1804, \textit{A. maculipennis} Meigen, 1818, \textit{A. messeae} Falleroni, 1926, \textit{A.
atroparvus} Van Thiel, 1927, \textit{A. plumbeus} Stephens, 1828, \textit{Culiseta annulata}
(Schrank) 1776, \textit{Cul. alaskaensis} (Ludlow) 1906, \textit{Mansonia richiardii} (Ficalbi) 1889.

The most abundant and therefore the most important in the biotope of inun-
dated forest were species of the genus \textit{Aëdes}, particularly \textit{Aë. vexans}, \textit{Aë. cantans},
\textit{Aë. sticticus}, \textit{Aë. cinereus} and \textit{Aë. communis}, whose occurrence and numbers de-
pended on the period and extent of floods (cf. Figs. 1, 2, 3 and 4).

NUMBERS AND PHENOLOGY OF MOSQUITOES IN SOUTHERN MORAVIA

During the vegetation period the predominant species of mosquitoes in the
biotope of inundated forest gradually interchange. According to the results obtained
by our studies \textit{Aë. communis} is the most abundant of the early spring species in
southern Moravia, occurring in abundance in the first half of May, while \textit{Aë. cata-
phylla} and \textit{Aë. leucemelas} are rare. From the middle of May \textit{Aë. cantans} predomi-
nates, while the other late spring species \textit{Aë. excrucians}, \textit{Aë. annulipes} and \textit{Aë.
flavescens} are less abundant. \textit{Aë. sticticus}, whose numbers in individual years have
fluctuated considerably, also occurs since May (cf. Figs. 6, 7 and 8).

The most abundant species occurring from the beginning of June has proved to be \textit{Aë. vexans} which hatches along with \textit{Aë. cinereus} from the end of May. The most abundant species \textit{Aë. cantans}, \textit{Aë. sticticus}, \textit{Aë. vexans} and \textit{Aë. cinereus} survive until the second half of the vegetation period, when the numbers of species with
several generations can be increased by the appearance of additional generation
following the repeated flooding of hatching sites, as observed in 1965 and 1966.
The data on the phenology of mosquitoes in southern Moravia are given in
a survey in Tables 1 and 2.
Hydrologic conditions. The influence of hydrologic conditions proved to be the strongest. Spring floods usually occur in southern Moravia whenever the water level in rivers is higher than normal. These floods prior to the beginning of the ve-

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<thead>
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<th>IV.</th>
<th>V.</th>
<th>VI.</th>
<th>VII.</th>
<th>VIII.</th>
<th>IX.</th>
</tr>
</thead>
<tbody>
<tr>
<td>decades</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>temperature</td>
<td>10-15</td>
<td>13-16</td>
<td>14-16</td>
<td>11-16</td>
<td>15-19</td>
<td>17-21</td>
</tr>
<tr>
<td>flooded</td>
<td></td>
<td></td>
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</tbody>
</table>

\[ \text{Fig. 1. Occurrence of mosquitoes, flooding of hatching sites and water temperature in hatching sites during the 1963 season in the Drnholec locality (II.—IV. — stages of larvae, P — pupae, ———— ascertained occurrence, - - - - - supposed occurrence).} \]
<table>
<thead>
<tr>
<th>Species</th>
<th>Stage</th>
<th>Period of occurrence</th>
<th>Maximum of occurrence</th>
<th>Number of generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aedes communis</td>
<td>larvae</td>
<td>1st dec. of April—1st dec. of May</td>
<td>April</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>3rd dec. of April—2nd dec. of May</td>
<td>3rd dec. of April—1st dec. of May</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st dec. of May—2nd dec. of June</td>
<td>2nd—3rd dec. of May</td>
<td></td>
</tr>
<tr>
<td>Aedes cataphylla</td>
<td>larvae</td>
<td>2nd—3rd dec. of April</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>2nd—3rd dec.</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>May</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Aedes cantans</td>
<td>larvae</td>
<td>3rd dec. of April—1st dec. of June</td>
<td>1st half of May</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>1st dec. of May—3rd dec. of June</td>
<td>2nd half of May</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd dec. of May—3rd dec. of August</td>
<td>2nd half of May—June</td>
<td></td>
</tr>
<tr>
<td>Aedes excrucians</td>
<td>larvae</td>
<td>3rd dec. of April—1st dec. of June</td>
<td>1st half of May</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>1st dec. of May—3rd dec. of June</td>
<td>June</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd dec. of May—2nd dec. of August</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aedes flavescens</td>
<td>larvae</td>
<td>3rd dec. of April—1st dec. of June</td>
<td>1st half of May</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>1st dec. of May—3rd dec. of June</td>
<td>2nd half of May—June</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd dec. of May</td>
<td>June</td>
<td></td>
</tr>
<tr>
<td>Aedes dorsalis</td>
<td>larvae</td>
<td>2nd dec. of April—1st dec. of June</td>
<td>—</td>
<td>more (2)</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>1st dec. of May</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st dec. of June</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Aedes sticticus</td>
<td>larvae</td>
<td>2nd dec. of April—1st dec. of June</td>
<td>May</td>
<td>more (2)</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>1st dec. of May</td>
<td>3rd dec. of May—2nd dec. of June</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>1st dec. of June</td>
<td>June</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>2nd dec. of June—3rd dec. of August</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aedes vexans</td>
<td>larvae</td>
<td>1st dec. of May—1st dec. of July</td>
<td>3rd dec. of May—2nd dec. of June</td>
<td>more (2)</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>3rd dec. of May</td>
<td>2nd dec. of June—2nd dec. of July</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st dec. of June</td>
<td>1st dec. of July</td>
<td></td>
</tr>
<tr>
<td>Aedes cinereus</td>
<td>larvae</td>
<td>3rd dec. of April—1st dec. of July</td>
<td>2nd dec. of May—2nd dec. of June</td>
<td>more (2)</td>
</tr>
<tr>
<td></td>
<td>pupae adults</td>
<td>2nd dec. of May</td>
<td>3rd dec. of May—2nd dec. of June</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st dec. of June</td>
<td>1st dec. of July</td>
<td></td>
</tr>
</tbody>
</table>
Vegetation period have no direct influence on the development of mosquitoes which may occur after the flood from the second half of March (see Water temperature). During the years of our studies the floods occurred 1—4 times annually, in 1964—1965 the floods occurred only during the vegetation period (Table 3). The volume of water in the Dyje river during the floods reached 101—350 cubic meters/sec, in contrast to the normal volume of 50 cubic meters/sec.

![Graph showing occurrence of mosquitoes, flooding of hatching sites, and water temperature in hatching sites during the 1963 season in the Nejdek locality.](image)

Fig. 2. Occurrence of mosquitoes, flooding of hatching sites and water temperature in hatching sites during the 1963 season in the Nejdek locality (II—IV — stages of larvae, P — pupae, —— ascertained occurrence, ———— supposed occurrence).
<table>
<thead>
<tr>
<th>Species</th>
<th>Stage</th>
<th>Period of occurrence</th>
<th>Maximum of occurrence</th>
<th>Number of generations</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Culex pipiens</em></td>
<td>larvae, pupae, adults</td>
<td>1st dec. of May—1st dec. of September 1st dec. of June—1st dec. of September 1st dec. of June—2nd dec. of October</td>
<td>July—August July—August July—August</td>
<td>more (3)</td>
</tr>
<tr>
<td><em>Culex modestus</em></td>
<td>larvae, pupae, adults</td>
<td>1st dec. of May—3rd dec. of August 3rd dec. of June—3rd dec. of August 2nd dec. of July—1st dec. of September</td>
<td>July—August July—August July—August</td>
<td>more (2—3)</td>
</tr>
<tr>
<td><em>Culiseta annulata</em></td>
<td>larvae, pupae, adults</td>
<td>2nd dec. of May—3rd dec. of August 1st dec. of June—1st dec. of September July—August</td>
<td>July—August July—August July—August</td>
<td>more (2—3)</td>
</tr>
<tr>
<td><em>Mansonia richardi</em></td>
<td>larvae, pupae, adults</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><em>Anopheles maculipennis</em></td>
<td>larvae, pupae, adults</td>
<td>3rd dec. of April—1st dec. of September 3rd dec. of May—1st dec. of September 1st dec. of June—1st dec. of September</td>
<td>June—August June—August June—August</td>
<td>more (3)</td>
</tr>
<tr>
<td><em>Anopheles claviger</em></td>
<td>larvae, pupae, adults</td>
<td>throughout the year April—August April—August</td>
<td>—</td>
<td>2—3</td>
</tr>
</tbody>
</table>
The flooding of the inundated area in the lower reaches of rivers during regular spread of water continues after the water level in the river bed is back to normal and depends on the meteorological factors—the air temperature, precipitation (Figs. 9, 10), sunshine and wind. These factors, hydrologic situation and weather conditions, especially in the beginning of the vegetation period, determine the extent of mosquito calamities.

<table>
<thead>
<tr>
<th>months</th>
<th>IV.</th>
<th>V.</th>
<th>VI.</th>
<th>VII</th>
<th>VIII</th>
<th>IX.</th>
</tr>
</thead>
<tbody>
<tr>
<td>decades</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

- **temperature**
  - 6-11
  - 10-15
  - 14-18
  - 10-13
  - 12 20
  - 10-21

- **flooded**

**Fig. 3.** Occurrence of mosquitoes, flooding of hatching sites and water temperature in hatching sites during the 1964 season in the Drnholec locality (II.—IV. — stages of larvae, P — pupae, —— ascertained occurrence, · · · · · — supposed occurrence).
The rain fall, after the floods subside, prolongs the existence of puddles and large water-covered areas and facilitates the maintenance of conditions favourable for the development of mosquitoes for longer periods, as observed in 1962 and 1963. The puddles which have resulted from a previous flood dry up, but sometimes new puddles are formed from rain water. However, they often do not exist long enough for the development of mosquito larvae to be completed in them. For example in the summer of 1963 the water resulting from the May floods remained in some places

Fig. 4. Occurrence of mosquitoes, flooding of hatching sites and water temperature in hatching sites during the 1964 season in the Nejdek locality (II.—IV. — stages of larvae, P — pupae, —— ascertained occurrence, ——- — supposined occurrence).
only until the beginning of June. After the heavy rains in the first half of June small hatching sites of larvae of *Aë. cantans*, *Aë. excrucians* and *Aë. vexans* have formed, but dried up by the end of June during the following warm and dry weather (Fig. 8) and their development could not be completed. In consequence no high numbers of mosquitoes occurred.

**Table 3. Survey of inundation of the Dyje river in individual years**

<table>
<thead>
<tr>
<th>Year</th>
<th>Pre-seasonal floods</th>
<th>In the vegetation period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>13. 2.—21. 2. 5. 3.—15. 3.</td>
<td>28. 3.—15. 4. 11. 5.—7. 6.</td>
</tr>
<tr>
<td>1963</td>
<td>12. 3.—23. 3.</td>
<td>29. 3.—15. 4. 5. 5.—10. 5.</td>
</tr>
<tr>
<td>1964</td>
<td>27. 3.—30. 3.</td>
<td></td>
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<tr>
<td>1965</td>
<td>27. 3.—5. 7.</td>
<td></td>
</tr>
</tbody>
</table>

**WATER TEMPERATURE IN HATCHING SITES**

During our studies the influence of water temperature upon the occurrence of larvae of individual species of mosquitoes in hatching sites and on the length of their development was traced. Larvae of the spring mosquito species developed

**Fig. 6. Proportional representation of individual species during the 1964 season in the Drnholec locality.**
at the water temperature of 6—18 °C, larvae of *Ae. vexans* at 7—21 °C. The values of the water temperature in hatching sites in individual years of our studies are given in Figs. 1, 2, 3, 4.

**CONDITIONS FOR THE OCCURRENCE OF MOSQUITO CALAMITIES**

By comparing the population dynamics of mosquitoes with ecological factors affecting them the favourable and unfavourable conditions for the occurrence of mosquito calamities can be determined.

a) The most favourable year for the occurrence of mosquitoes was the year 1963. During the first flood in the vegetation period (Table 3) only lower situated ditches and depressions in the Drnholec locality were overflowed and became the hatching sites of spring species. The water temperature in the hatching sites is given in Fig. 1. After an additional flood in May (Table 3) the hatching sites in depressions were filled with water until the first decade of June, because throughout that period the water level in the depressions was maintained nearly at an unvaried level due to heavy rainfall (Fig. 9). The hatching of spring and spring-summer species in that period is shown in Fig. 1.

![Fig. 7. Proportional representation of individual species during the 1964 season in the Nejdek locality.](image)

![Fig. 8. Proportional representation of mosquitoes after summer floods in 1966 in the Drnholec locality.](image)

In the Nejdek locality only small temporary pools not deeper than 50 cm formed after the second flood in the first half of April. The occurrence of larvae and the hatching of adults of the early spring and spring-summer species, as well as the water temperature in hatching sites, is shown in Fig. 2. The number ratio of adults of individual species in that locality is given in Fig. 11.

The numbers of adults in both localities studied gradually increased during May, the highest numbers were recorded in the Drnholec locality in the first decade of June, in the Nejdek locality in the third decade of June, i.e. shortly before the insecticide spraying which caused a marked decrease of the mosquito numbers. In the following vegetation period they were maintained at a low level. The repeated
Fig. 9. Numbers of mosquitoes during the 1963 season (Drnholec locality—thick line, Nejdek locality—thin line, insecticide spraying indicated by arrow), 10-day average air temperatures in °C and monthly totals of rainfall in mm (-----) compared with long-term average air temperatures in °C and average totals of rainfall in mm (-----) and duration of floods.

Fig. 10. Numbers of mosquitoes during the 1964 season (Drnholec locality—thick line, Nejdek locality—thin line), 10-day average air temperatures in °C and monthly totals of rainfall in mm (-----) compared with long-term average air temperatures in °C and average totals of rainfall in mm (-----) and duration of floods.
flooding of hatching sites in the second half of the vegetation period did not take place and the mosquito population consisted of the surviving adults (Fig. 9).

A relatively high air temperature as early as in the second decade of April and plenty of water in the hatching sites in 1963 were favourable for the mass deve-

![Pie charts showing proportional representation of individual species during the 1963 season in the Nejdek locality.](image)

Fig. 11. Proportional representation of individual species during the 1963 season in the Nejdek locality.

lopment of larvae of the spring and summer species. The adults of the spring species hatched from the first decade of May, the main calamitous species *Aë. vexans* as early as from the middle of May.

Under similar conditions a calamitous mass occurrence of mosquitoes could be anticipated.

b) Marked unfavourable conditions were recorded in the dry year 1964, and in 1965 during exceptionally long-lasting floods (Fig. 12) which particularly influenced the development of the main calamitous species *Aë. vexans*. The year 1964, in comparison with the long-term average, was much drier and warmer (Fig. 10). The Dyje river overflowed its banks only once (Table 3) at a relatively low volume of 100 cubic meters/sec.

In the Drnholoč locality only low places in hollows were flooded, the water in them persisted in April and

![Graph showing changes in the water level of the Dyje river on the stream gauge profile Dolní Věstonice in the long-lasting floods of 1953.](image)

Fig. 12. Changes in the water level of the Dyje river on the stream gauge profile Dolní Věstonice in the long-lasting floods of 1953 (——— water level, ————— flood mark).
May. Larvae of the spring species occurred there from the first decade of April; their development, the water temperature, as well as the occurrence of spring-summer species, are shown in Fig. 3.

In the Nejdek locality the extent of floods was also relatively small, the hatching sites originated only in low places (vicinity of the gamekeeper’s lodge near Nejdek, ditches in forest). The development of larvae of the spring species and the water temperature in hatching sites is shown in Fig. 4. Infrequent larvae of *Ae. vexans* and *Ae. cinereus* occurred in the third decade of April, the adults hatched from the third decade of May.

*Fig. 13. Air temperature and amount of rainfall during the vegetation period of 1965 (---) compared with long-term average (-----).*

*Fig. 14. Numbers of mosquitoes during the 1965 season (Drnholec locality—thick line, Nejdek locality—thin line, insecticide spraying indicated by arrow).*

The total numbers of mosquitoes in 1964, in contrast to both previous years, were low (Fig. 10), the area of hatching sites was distinctly smaller. The proportional representation of individual mosquito species in both localities and its changes during the vegetation period are shown in Fig. 6 and Fig. 7.

In 1965 the population dynamics and phenology of mosquitoes in the area studied was seriously influenced by an exceptionally long-lasting flooding (Table 3). Ac-
According to the stream gauge profile of the Dyje river (Fig. 12) three culminations of floods occurred during that period, but practically for 4 months the inundated forests in southern Moravia were flooded by flowing water as high as 1 m, the meadows even higher. The air temperature during the vegetation period was relatively low, the rainfall was higher than the long-term average (Fig. 13).

The development and hatching of spring species was normal during April and May. During the development of the main calamitous species Aë. vexans at the end of May the hatching sites were repeatedly flooded with a high layer of streaming water (Fig. 12). The first, usually the most numerous generation of Aë. vexans was reduced by these exceptional hydrologic conditions to sporadic specimens occurring as late as from the middle of June. The species Aë. sticticus which had been less abundant in previous years (cf. Figs. 6 and 15) predominated in numbers (Miňák 1966). The population dynamics of mosquitoes in the vegetation period are given in Fig. 14. Infrequent adults of Aë. vexans still occurring in the Drholec locality in the first decade of August, survived according to the results obtained by the dissection of ovaries from the spring generation (Hájková 1966b).

Likewise in the Nejdek locality the development of the spring species Aë. communis, Aë. cantans, Aë. excrucians and Aë. sticticus took place without any considerable deviations, the mosquitoes hatched in the second decade of May. No larvae of Aë. vexans neither the larvae of I. stage of the genus Aëdes were detected. At the beginning of June during the second rise of the water level the inundated forests were flooded by flowing water. In June no mosquito larvae occurred in the inundated area. At the beginning of July insecticide spraying was carried out in this locality because of large numbers of mosquitoes of spring species.

After the third flood which began in the third decade of July, larvae of I. stage
of *Ae. vexans* and *Ae. cinereus* appeared at the beginning of August, the adults of this generation hatched in the second half of August. The average species representation during the vegetation period in this locality is given in Fig. 16. In the first half of the vegetation period *Ae. cantans* was predominant, in the second half it was *Ae. sticticus*. The number of *Ae. vexans* was exceptionally low, similarly as in the Drnhopec locality.

The unfavourable influence of exceptional floods in 1965 upon the number of the species *Ae. vexans* became manifest also in the following year. The development of spring species did not basically differ from the conditions in other years; in the Drnhopec locality, after a small flood in the first decade of April, infrequent larvae of the species *Ae. communis*, *Ae. cantans* and *Ae. excrucians* developed in small puddles. In the third decade of April larvae of IV. stage of *Ae. cantans* and *Ae. excrucians* were detected and the hatching of *Ae. communis* was observed. In May and June infrequent adults of these species were found.

![Pie charts](Fig. 16. Proportional representation of individual species during 1965 in the Nejdek locality.)

Infrequent larvae of *Ae. vexans* were found in their hatching sites in the second decade of July after a repeated flooding of the Dyje river in the first half of July. The adults of this species represented 45% of the total low population of mosquitoes in the first decade of August. Larvae of *Ae. vexans* appeared in abundance in their hatching sites as late as in the second decade of August after a third flooding of terrain due to heavy rains. Only in this second generation the numbers and proportional representation corresponded with the conditions observed in previous years.

A similar situation was ascertained in the Nejdek locality. The mosquitoes *Ae. vexans* and *Ae. cinereus* of this late second generation survived under exceptionally warm weather in the autumn of 1966 until the end of October.
SURVIVAL OF ADULTS AND CONTROL MEASURES

The highest numbers of mosquito species occurring in large masses and causing calamities in southern Moravia are encountered in the second half of June. In this period the majority of late spring species *Aë. cantans*, *Aë. excrucians*, *Aë. flavescens* survive and main masses of the species *Aë. sticticus*, *Aë. cinereus* and particularly *Aë. vexans* hatch. The course of the population curve of mosquitoes without any disturbance in their normal development in 1964 is shown in Fig. 10; in 1963 the increasing average numbers of mosquitoes in June were abruptly reduced by insecticide spraying (10% emulsion of DDT amounting to 5.5 kg per ha).

The effectiveness of extensive spraying which harshly interferes with natural biocenosis, is considerably limited in time. As early as during the following year (1964), when hydrologic and meteorologic conditions were unfavourable to the development of mosquitoes, their numbers increased to such an extent that in the subsequent year the spraying had to be repeated. From the aspect of the suppression of mosquito calamities this method is not nearly sufficient enough.

The predominant calamitous species are the spring-summer and summer species *Aë. vexans*, *Aë. sticticus* and *Aë. cantans*, which may produce several generations in one year, depending on the number, time and extent of floods. In 1965—1966 two generations of *Aë. vexans* appeared, while in 1962—1964 not more than one generation of this species was hatched. The females of the first generation, however, survived practically throughout the season—three or four months, which fact is of great epidemiological importance, because the repeated feeding of mosquitoes enhances the probability of the spread of infection.

The survival of adults for longer than 3 months was ascertained also with spring-summer species *Aë. cantans* and *Aë. excrucians* which produce only one generation. The species *Aë. cantans* participates in the mosquito calamities in the first half of the vegetation period. For example in 1965 the eradication measures by insecticide spraying from the air affected the species *Aë. cantans* and *Aë. sticticus* at the time of their maximum occurrence.

DISCUSSION

Only a very slight difference between the occurrence of early spring species (e.g. *Aë. communis*) and of some late spring species (*Aë. cantans*, *Aë. excrucians*) according to the differentiation of Kramár (1955) was revealed in southern Moravia. Larvae of *Aë. communis* and *Aë. cantans* were found in hatching sites almost simultaneously, while the adults in nature appeared with the difference of several days. In some years the larva of early spring and late spring species, particularly of *Aë. cinereus* and *Aë. sticticus*, developed simultaneously from the second half of April.

The vegetation period in 1965 represented an exception in the regular population dynamics of most abundant species of mosquitoes in southern Moravia.
A striking disappearance of the abundant to calamitous species _Aë. vexans_ after extraordinary floods in that year can be explained by the flooding of hatching sites of this species with a high layer of streaming water at the time of its development. The water temperature reached normal values and was suitable for the development of larvae. But the streaming water washed away the hatched larvae and later the high water layer containing decomposing substances was an unfavourable environment for the hatching and further development of larvae. An unfavourable factor in the late spring period might have been also a marked increase in number of their natural enemies (frogs and fish fry), which developed in the extensive submerged places.

**CONCLUSION**

In 1962—1966 long-term studies were carried out on the population dynamics of mosquitoes, their phenology and the influence of some ecological factors. Five genera and 24 species of mosquitoes were found.

The extent of mosquito calamities is determined by hydrologic situation and meteorologic conditions, particularly at the beginning of the vegetation period. The development of the first generation of most abundant mosquito species in that period is the most important fact for the occurrence of mosquito calamities. The predominant calamitous species are _Aë. vexans, Aë. cantans, Aë. sticticus_ and _Aë. cinereus_, whose numbers reach their maximum in the second half of June. The most abundant species is _Aë. vexans_ which produced 1—2 generations.

From the epidemiological aspect the survival of mosquitoes of the first generation for more than three months, i.e. practically throughout the vegetation period, is a very important finding.

The effect of extensive insecticide spraying was balanced by a natural increase of population during the subsequent year, when the spraying was omitted.

A regular interchange of most abundant species during the vegetation period and phenologic data of the mosquito species studied were ascertained.

The most favourable conditions for the development of mosquitoes were recorded in 1963. Exceptional long-lasting floods in 1965 considerably influenced the number ratio and population dynamics of the species studied and suppressed the species _Aë. vexans_ which is predominant under normal conditions. This influence was still manifest in the subsequent vegetation period.

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